



5.2.2 Protect and Incorporate Natural Flow Paths

Description

Most sites have discernible topographical drainage features that direct stormwater generated on the site. By identifying, protecting, and preserving these natural flow paths, a development can minimize its stormwater impacts. Rather than ignoring or replacing natural drainage features with engineered systems that capture runoff and convey it downstream, designers can preserve these features, thereby reducing or eliminating the need for structural drainage systems.

Natural drainage features include:

- Swales
- Ephemeral and intermittent streams
- Headwater springs
- Depressions

The natural meandering pattern of water slows the velocity of runoff and provides opportunities for infiltration, uptake, storage, and filtration by plants and soil. The greatest difference in runoff between a natural and an altered site occurs during small storms (rainfall events) and early on in a larger storm. Most of the increase in runoff volume occurs because altered soils and horticultural plantings (turf, etc.) cannot absorb this first portion of the rainfall and because natural drainage channels have been straightened, lined, buried, or “graded away,” allowing water to drain quickly.

To effectively protect natural drainage features, they should be integrated in designs and used to organize the site program. Design additions to natural drainage features can make them more effective. For example, constructing low earthen berms around natural depressions creates additional flood storage; installing check dams within a drainage flow path slows runoff, fills gullies, and catches sediment; and planting additional native vegetation helps stabilize the banks and increase biofiltration.

BMP Functions Table

BMP	Applicability	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Protect and Incorporate Natural Flow Paths	U/S/R	H	H	M	H	M	M	H	L	L

KEY: U = Urban; S = Suburban; R = Rural; H = High; M = Medium; L = Low





Key Design Guidelines

- Identify site location within the watershed (floodplain, headwater stream, etc.).
- Identify and locate on site survey and site plan the natural drainage features of the site (swales, channels, ephemeral streams, depressions, etc.), for protection early in the design process.
- Preserve existing plant material within the state-mandated buffer zone and at the edge of these flow paths. The NPDES general stormwater permit for Tennessee requires a 30-foot average buffer along all streams (60 feet on 303d-listed or high-quality streams).
- Reduce proposed or existing impervious footprints, where possible, to maintain natural flow paths. Use natural drainage features to guide site design.
- Do not bury or “grade away” natural drainage flow paths.
- Minimize filling, clearing, or other disturbance of natural drainage features.
- Utilize natural drainage features instead of creating engineered systems whenever possible.
- Distribute least erosive surface flow to natural drainage features.
- Plant native vegetative buffers around drainage features.

Advantages

Retaining the natural configuration of drainage channels and their deep-rooted vegetation can:

- Slow runoff.
- Reduce stormwater runoff by providing dispersed, small-scale storage.
- Reduce peak discharges.
- If preserving a stream and buffer, avoid the need for an Aquatic Resource Alteration Permit (ARAP) and stream mitigation measures.
- Improve water quality through biofiltration, treating stormwater before it enters wetlands, lakes, and streams.
- Allow some infiltration and evapotranspiration.
- Provide recreational open space and place for site trails.
- Provide wildlife habitat.
- Improve site organization and aesthetics by treating drainage as an aesthetic feature.
- Raise property values.
- Natural drainage pathways can replace structural drainage systems and lower stormwater management costs.



Figure 5.2.2-1. Open water channels for drainage (either natural or manmade) are still common within the Chattanooga region. In some cases, these channels have been straightened and lined with rip-rap or concrete. They can be found even on very urban sites, such as this one at the Hamilton Place Mall.





Disadvantages

- Additional time may be required to identify and integrate natural drainage features into the design. (However, these costs may be offset by reductions in “structured” stormwater facilities and site grading.)

Applications

- Any land development—large or small, urban, suburban, or rural—with identifiable natural or culturally significant drainage features.

Design measures to protect natural flow paths can be applied at multiple scales and with varying levels of formality and therefore are applicable for most types of projects (residential, commercial, industrial) at any scale and in any location (urban, suburban, or rural). The most obvious use of these strategies is within a residential, corporate, or institutional campus with increasing degrees of formality (geometric design). Protection of drainage flow paths can be applied to major streets or dense urban developments.



Figure 5.2.2-2. In densely urban areas—on streets, plazas, side yards, parking areas, etc.—drainage can be reinterpreted and integrated as a formal design with formal and ornamental plantings into the site amenities offered.

Applicable Protocols and Specifications

Protocol 5 Planting Guidelines

Design Considerations

Site Analysis

Identify and incorporate the site’s fundamental hydrologic patterns as part of the overall stormwater design. This can include the restoration of remnants or recreation of historic natural drainage features (swales, depressions, watercourses, ephemeral streams, etc.). These restoration strategies are discussed in Section 5.4.1, Recreate Natural Flow Patterns. However, existing site features should be



Figure 5.2.2-3. Existing drainage corridors and their buffering vegetation can be expressed as a rural drainage ditch.





protected and may be enhanced for stormwater performance. The creation of a number of strategies and measures to increase functions (slow down, retain, and infiltrate runoff, etc.) are discussed in the next section. In order to implement any of the above-mentioned strategies, a site analysis must be performed.

- Understand the location of the site within the local watershed. Identify whether the site is within (or includes) a headwater stream, a floodplain, etc. This will provide clues as to how the water moves through the site. For example, headwater areas have soils and topography that are more likely to infiltrate, whereas slow conveyance is a strategy in floodplains and areas with high water tables.
- Survey and map natural existing drainage features (swales, channels, ephemeral streams, wet depressions, etc.).
 - Using a site topographic survey, identify the context of existing flow patterns and volumes for mini-watersheds/drainage areas, including where water presently drains and whether it sheet flows and/or concentrates in channels.
 - Natural waterways that are providing important woody wildlife cover and if not seriously eroding should not be disturbed (they are of high value).

Design Strategies

The design goal is to identify and use the site's fundamental hydrologic patterns to create dispersed, decentralized, small-scale stormwater management measures that work with the natural hydrology wherever possible.

- Use natural drainage features to help structure and organize the site design based on a site analysis of existing drainage patterns (from topographic survey, etc.). Where possible, design proposed site drainage patterns to protect and support natural surface (and subsurface) hydrology.
 - Avoid building over or burying drainage areas by using cluster design, or concentrating uses to serve multiple functions including roads, buildings, and parking around drainage pathways.
 - Set aside drainage pathways in “Protected Areas” or “Minimal Disturbance Areas” and integrate them with open space networks.
 - Minimize filling, clearing, straightening, or other disturbance of drainage features to be protected.
- Using the natural drainage pathways to accept additional runoff from new development is appropriate. Utilize natural drainage features instead of hard engineered systems whenever possible.



- If an existing natural drainage pathway is to be used, it may need to be selectively cleared, shaped, or enlarged to accommodate the design flow. It also must be checked to ensure stability. Provide measures to reduce volume and velocity within or before the water reaches these flow pathways.
 - Engineer stormwater volume and velocity to ensure that the existing drainage features are sustained, and not degraded over time.
 - Reinforce the bottom of the swale, with porous materials, where necessary.

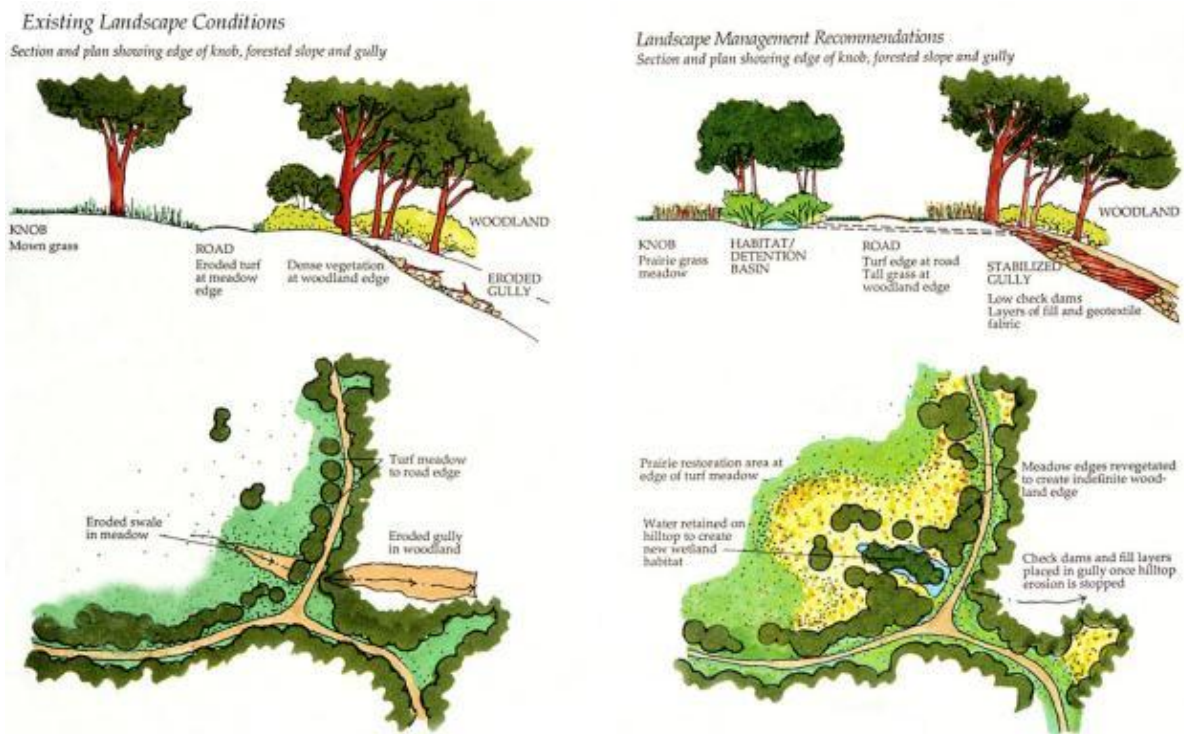


Figure 5.2.2-4. Enhancing existing flow patterns for stormwater performance.



Figure 5.2.2-5. Stone reinforced swale.



Figure 5.2.2-6. Reinforced swale bottom and check dam.

- Direct the least-erosive stormwater flows to natural drainage pathways. Use level spreaders, energy dissipaters, check dams, etc. to slow down and disperse water flow, especially at points of inflow.
- Buffer flow path banks and bank edges with the appropriate, deep-rooted vegetation to treat stormwater runoff and stabilize channel sides. Protect or establish a buffer of meadow or woodland adjacent to the channel to slow water and provide biofiltration (manage non-point source pollution).



Figure 5.2.2-7. Buffer vegetation along flow path banks.





- Channel design—Wherever possible, preserve natural meanders. Use rocks and logs to create deflectors that modify the speed and direction of the water flow, or low dams to create small pools. See Sections 5.4.1, Recreate Natural Flow Patterns and 5.4.1.1, Naturalize Swales and Drainage Ditches, in this manual for more information about reconfiguring channel design.
 - If the drainage flow path is presently in turf or bare soil, or has fragmented vegetative cover, reinforce vegetation with appropriate new plantings. See Section 5.4.1, Recreate Natural Flow Patterns.
- Link drainage flow paths and other stormwater management features together as a mutually reinforcing system.
 - Look for opportunities to divert flow out of existing engineered structures, or repurpose existing engineered structures as overflows.
- Take advantage of opportunities to create even very small-scale storage of water (reusing even small swales or small basins to act as wetlands to provide water storage and infiltration).
- Preserving and protecting wet depressions will encourage recharge of groundwater over the site and will help restore historic flow in streams that now appear dry.
- Careful use of natural flow paths can lengthen the Time of Concentration (T_c) value used in calculating peak flow rates. Correspondingly, decreasing the T_c will reduce the peak rate of flow. This may reduce the required detention storage volume, and may also reduce the size of stormwater structures such as pipes.



Figure 5.2.2-8. Channel design in construction.



Figure 5.2.2-9. Rain garden during construction using existing stormwater pipes as overflow (note domed riser at center).



Figure 5.2.2-10. Incorporate small-scale storage features.





Construction Sequence

- At the start of construction, natural drainage features to be protected should be identified and surveyed. These features must be included on both the site plan and the construction protection plan drawings.
- Immediately before construction, these features should be flagged and fenced.
- “Protected Areas” and “Areas of Minimal Disturbance” should be strictly delineated and enforced.
- Natural drainage features should be protected from additional sediment and stormwater loads generated by site disturbance during construction. Additional sediments from construction can form a limiting layer or soil crust that inhibits stormwater infiltration.

Operations and Maintenance

Natural drainage features that have been properly protected and integrated into the site development will still require occasional management to ensure that they remain attractive and functional. Periodic inspections, as well as targeted yearly maintenance, are important and must be included in the maintenance program agreements. Inspections should assess any developing problems—erosion, bank stability, sediment/debris accumulation, infested or dying plants, and also the presence of invasive species (both plant and animal). Problems should be corrected in a timely manner to avoid compounding these effects.

For new planting, watering, weeding, mulching, replanting, etc. may be required especially during the first year after planting. In addition, if the region is suffering from a prolonged drought, fragile areas with important stormwater functions should be watered to ensure that the vegetation lives. Invasive exotics (see list in Planting Protocol) should be removed and the flow path replanted with desirable replacements.

Placing protected drainage features on private property under easement, deed restrictions, or other legal measures will help prevent future impacts and will provide tax abatements for the property owner.

References

Adams, Michele and Donald Watson. 2011. *Design for Flooding: Architecture, Landscape, and Urban Design for Resilience to Climate Change*, Wiley & Sons. 2011.

Riley, Ann L. 2009. *Restoring Streams in Cities: A Guide for Planners Policymakers and Citizens*. Island Press.

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<http://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21429>.





Criteria Checklist BMP 5.2.2

ITEM DESCRIPTION	YES	N/A
The following checklist provides a summary of design guidance by the owner/applicant for successful implementation.		
<ul style="list-style-type: none"> Identify site location within the watershed (floodplain, headwater stream, etc.). 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Identify and locate on site survey and site plan the natural drainage features of the site (swales, channels, ephemeral streams, depressions, etc.). 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Natural drainage features have been designated “Protected Areas” and/or “Areas of Minimal Disturbance” and are delineated clearly on the Existing Conditions Assessment, Site Protection Plan, Grading and Soils Plan, Erosion and Sediment Control Plan, and Stormwater Plan. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Natural flow pathways in “Protected Areas” or “Areas of Minimal Disturbance” are integrated with open space networks. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> “Protected Areas” and/or “Areas of Minimal Disturbance” are safeguarded from sediment and stormwater loads during construction and opened only after construction is finished and vegetation has been established. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Protection, fencing details, and associated signage details for “Protected Areas” and/or “Areas of Minimal Disturbance” have been provided. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> No filling, clearing, straightening or other disturbance of drainage features to be protected. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Additional stormwater, directed to existing natural flow path, have been engineered for volume and velocities to ensure they are not degraded over time. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Reinforce the bottom of the swale, with pervious materials, where necessary. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Direct the least-erosive stormwater flows to natural drainage pathways. Use level spreaders, energy dissipaters, check dams, etc. to slow down and disperse water flow, especially at points of inflow. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Buffer flow path banks and bank edges with the appropriate, deep-rooted vegetation to treat stormwater runoff and stabilize channel sides. Protect or establish a buffer of meadow or woodland adjacent to the channel, to slow water and provide biofiltration (manage non-point source pollution). 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Channel design—wherever possible, preserve natural meanders. Enhance existing flow paths with rocks (not rip-rap) and logs to create deflectors that modify the speed and direction of the water flow, or low dams to create small pools. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> If the drainage flow path is presently in turf, or bare soil, or has fragmented vegetative cover, reinforce vegetation with appropriate new plantings. 	<input type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Drainage flow paths and other stormwater management features are linked together, as a mutually reinforcing system, and small-scale storage is incorporated. 	<input type="checkbox"/>	<input type="checkbox"/>

